Forest Health Protection
Pacific Southwest Region

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To: District Ranger, Almanor Ranger District, Lassen National Forest

Subject: Evaluating the hazard potential of fire-injured trees within the Cub Complex Fire (FHP Report NE10-02)

At the request of Brenda Barton, Lead Sale Administrator, Almanor Ranger District, I visited the Cub Complex Fire on October 20, 2009 to evaluate the condition of fire-injured trees along Forest Service system roads. The objectives of this visit were to assess tree injuries, discuss current and potential insect and disease activity, and help design site specific marking guidelines for hazard trees. Recommendations provided in this evaluation will assist the District in making hazard tree determinations to meet roadside safety objectives. Brenda Barton and Adam Bianchi accompanied me in the field.

Background

The Cub Complex Fire burned 19,780 acres between June 21 and July 20, 2008 in the Cub Creek watershed about 14 miles southwest of Chester, CA (T27N, R4E, Sections 21, 22, 27 and 28). The elevation of the site ranges between 4,200 and 4,800 feet and receives an average of 55" of annual precipitation. Forest composition at lower elevations and on south facing slopes is primarily ponderosa pine (*Pinus ponderosa*) with scattered incense cedar (*Libocedrus decurrens*) and Douglas-fir (*Pseudotsuga menziesii*). Upper elevation and north slope stands consist of white fir (*Abies concolor*) with scattered sugar pine (*Pinus lambertiana*). The management objectives for this roadside hazard tree project are to remove dead and structurally defective trees, due to severe fire-injury or other pre-fire conditions (e.g. decay or excessive lean), that are within striking distance of the road prism.

Observations

Fire-injuries sustained by trees within the Cub Complex are typical for most mixed severity fires

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in the Sierra Nevada, ranging from light heat scorching of crowns and light basal charring to complete consumption of foliage and severe cambial kill. Fire caused crown and bole injuries within the Cub Complex vary by site, species and tree diameter. There are also areas of complete crown consumption of all trees species scattered throughout the fire area.

Many white fir trees, with significant amounts of unburned green foliage, were found to have sustained deep charring on their lower boles that killed cambium tissue. Sapwood under these deeply charred areas is already beginning to decay. Smaller diameter white fir (<24") appear to have sustained more extensive bole injuries than larger diameter trees. Woodboring beetles such as flatheaded borers (Family: Buprestidae), roundheaded borers (Family: Cerambycidae) and ambrosia beetles (such as *Trypodendron* spp.) have successfully attacked trees in and adjacent to patches of fire-killed cambium, accelerating the decay process.

Many green crowned sugar pine trees have also sustained significant lower bole fire-injuries. These trees are producing copious amounts of resin and are also being attacked by woodboring beetles as well as red turpentine beetles (*Dendroctonus valens*). Sugar pines of all size classes appeared to be equally susceptible to lower bole injuries.

Ponderosa pine with green crowns sustained fewer bole injuries overall except for large diameter trees that were surrounded by deep duff and litter layers. When this surface fuel was consumed by the fire, it killed significant amounts of cambium at tree root collars.

No Douglas-fir and incense cedar trees were examined as there are very few of these species within the project area.

Bole injuries for all species were more severe when trees were adjacent to high burn severity pockets, bark charring extended high on the bole, and/or when adjacent down logs or other debris burned in close proximity causing lethal heating.

Trees of all species were examined for needle retention within fire-killed portions of the crown to determine if Forest Health Protection (FHP) fire-injured tree marking guidelines could be used to predict tree mortality. After recent storms, many needles and small branches have fallen but pre-fire crown length can still be determined for most trees.

Discussion

FHP has developed both fire-injured tree marking guidelines for evaluating California conifer species and hazard tree marking guidelines for evaluating trees that have structural defects or are impacted by insects and disease. These guidelines were designed to give land managers a range of options to meet project specific objectives. The following discussion of the use of these guidelines is specific to the Cub Complex.

Forest Health Protection fire-injured tree marking guidelines (Smith and Cluck 2009):

Most trees within the Cub Complex still retain enough fire-killed needles and small branches to make an accurate determination of crown kill (as a percentage of the pre-fire crown length). However, one or two more significant wind events could remove enough dead needles and fine branches to make accurate crown evaluations impossible. If the FHP fire-injured tree marking

guidelines are to be used for this project, they will need to be implemented immediately to insure a high level of accuracy. If trees are not evaluated before the onset of winter storms, which would now be the second winter post-fire, the FHP guidelines should not be used.

If tree marking begins immediately, crews should understand that some trees may not be suitable for crown evaluations due to recent needle cast. If there is uncertainty regarding the pre-fire crown length, the tree should not be evaluated using the FHP guidelines. Another option is to choose a very conservative probability of mortality level, as described in the guidelines, that will error towards leaving questionable trees (e.g. using a Pm = 0.9 instead of a Pm = 0.7).

Based on FHP monitoring of past Sierra Nevada fires, approximately 80% of the expected tree mortality within the Cub Complex will occur within 2 years post-fire (by summer 2010), therefore using the fire-injured tree marking guidelines at this late date will not likely capture much additional mortality above what will be marked simply as "black and brown", or dead trees, from now until next summer when danger tree abatement operations begin.

Hazard tree guidelines (Cluck and Woodruff 2008)

These guidelines discuss the types of structural defects and insects and diseases that are associated with hazard trees (now referred to as "Danger Trees" in current FSH direction). In order for a tree to be considered a danger tree it must meet certain criteria and most importantly be within striking distance of people or property (including roads). The level of danger is determined by a qualified individual using a combination of the value of the target and the defects of the tree. For example, a tree that shows signs of decay that is located next to a low use road will likely be considered much less of a danger than the same tree located next to a developed campsite. Knowledge of previous tree failures and unique site conditions, e.g. wet soils, high wind area, and presence of root disease, can help make these determinations.

The potential for fire caused structural damage that may create a hazardous situation is not discussed in detail in the FHP fire-injured tree or hazard tree marking guidelines. However, FHP monitoring of fire-injured trees has revealed the potential for significant decay to develop in portions of the bole where cambium was heat killed. This is particularly true for fire-injured true fir, as green trees that develop extensive sapwood decay can fail in as few as three years (Report: SPR-07-05). The rate of failure can increase dramatically after the fourth year post-fire, especially in conjunction with high winds or heavy snows. True fir trees with these types of bole injuries should be carefully inspected to determine hazard potential if they are within striking distance of people or property (Appendix A).

Fire-injured tree failures on the Lassen and Plumas National Forests:

During the 1999 Bucks Fire on the Plumas National Forest the crowns of many true firs were lightly to moderately scorched. These same trees suffered moderate to severe cambium injury and in some cases near complete girdling. Following the fire, frass and/or boring dust from wood boring and ambrosia beetles were evident on many of the tree boles, which is often indicative of internal injury. Bark sloughing over the last several years from the injured areas of the bole and root collar has revealed extensive decay of the sapwood; however, most of these trees have maintained green crowns. During the fourth year post-fire, a few trees within the burn that had green crowns and extensive bole decay failed. In the fall of 2004, after an early storm brought heavy snow and wind, many more fire-injured trees failed that had these same decay

characteristics. This has also been observed in the 2001 Star Fire (Tahoe National Forest) and the 2000 Storrie Fire (Lassen National Forest).

In addition to these past observations, I revisited a small portion of the 2000 Storrie Fire on the same day as the Cub Complex visit and observed approximately 25 more true fir that had failed with full green crowns within the last year. These trees suffered various levels of cambium kill during the fire and the decay of the lower boles was nearly complete. All of these failed trees were adjacent, or in some cases, across Forest Service system roads.

Determining when fire-injured and fire-killed trees will fail

There is no accurate method of predicting when fire-injured and fire-killed trees will fail; any tree can fall at any time due to a variety of factors. Fire-killed and fire-injured trees have higher probabilities of failure than uninjured and healthy trees. However, based on the available literature and FHP monitoring, the majority of fire-killed and fire-injured trees, specifically fire-injured true firs with significant bole injuries, will not begin to fail until the third post-fire year.

Recommendations

The following recommendations are based on the condition of trees observed within the Cub Complex and long-term monitoring of fire-injured trees in similar forest types on the Lassen and Plumas National Forests.

Recommended danger tree marking criteria (distance from road prism should be determined by tree height, slope, or other site specific conditions):

1) Mark all dead trees regardless of species.
2) Mark trees with structural defects as outlined in the FHP hazard tree guidelines.
3) Mark trees with evidence of significant bark and/or wood boring beetle activity over 1/3 of the bole circumference (Appendix B).
4) Mark all white fir and red fir that have deep charring (Appendix C) over 1/3 of the bole circumference.
5) Mark all sugar pine, ponderosa pine, incense cedar and Douglas-fir that have deep charring over 1/2 of the bole circumference.

Deep charring is more likely to be observed on trees next to high burn severity patches, on trees that have charring extending high on the bole, and on trees that had downed logs or other debris burn next to the bole.

These recommendations are only designed to capture the majority of future danger trees within the Cub Complex during this initial entry. Further inspections and subsequent abatement efforts will be required as additional trees die from their fire-injuries or evidence of more extensive bole decay becomes apparent on individual trees over the next several years.

FHP is available to train marking crews in danger tree identification for the Cub Complex Fire and to further assist in developing site specific guidelines. FHP is also available to assist with NEPA, including providing guidance on new FS Handbook direction for roadside danger tree abatement.

If you have any questions regarding this report and/or need additional information please contact me at 530-252-6431 or dcluck@fs.fed.us.

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Appendix A: Hazard Tree Alert

USDA Forest Service, Forest Health Protection, Northeastern California Shared Services Area

Hazard Tree Alert

True firs that survived wildfires are failing in as little as three years

During the 1999 Bucks Fire on the Plumas National Forest the crowns of many true firs were light to moderately scorched. However, these same trees suffered moderate to severe cambium injury and near complete girdling in some cases. Following the fire, frass and/or boring dust from wood boring and ambrosia beetles was evident on many of the tree boles, often indicative of internal injury. Bark sloughing over the last couple of years from the damaged areas of the bole and root collar has revealed extensive decay of the sapwood, however, most of these trees have maintained green crowns. During the fourth year post-fire, a few trees within the burn that had green crowns and extensive bole decay failed. In the fall of 2004, after an early storm brought heavy snow and wind, many more trees failed with these same characteristics. This has also been observed recently in a few fir trees in the 2001 Star Fire (Tahoe National Forest) and the 2000 Storrie Fire (Lassen National Forest). Based on the number of failed green trees observed this year in the Bucks Fire, true firs in these other fire areas are likely to start coming down at a higher rate within the next couple of years. People working in these areas or any other recently burned areas that contain red or white fir with similar fire injury, i.e. moderate to severe bole scorch with light to moderate crown scorch, should consider these trees hazardous until a closer inspection of the bole is completed. Forest Health Protection is currently working on fire-injured tree evaluation criteria to facilitate the early identification of trees that may succumb to the type of decay and failure presented here. For more information, contact Sheri Smith or Danny Cluck of the Forest Health Protection staff at 530-257-2151.

Black trees.....Be on the lookout for hazardous trees in burned forests. This kind of warning is common when conducting work in areas that have experienced wild or prescribed fires. Fire-killed trees are usually abundant and begin to fall about 3-5 years post-fire, creating very hazardous working conditions. Performing your job in these areas requires you to be extra cautious at a minimum, and under certain weather conditions such as wind, to stay out of areas entirely. Walking a wide path around existing snags is one way to reduce the odds of being struck should one fail.

Green trees.....But what about the surviving trees? Recent monitoring of fire-injured trees has revealed the failure of 8" to 24" dbh red and white fir, with green crowns, in as little as three years. The rate of failure increases dramatically after the fourth year post-fire, especially in conjunction with high winds or heavy snows.

Extensive bole charring on this "live", 12" dbh red fir resulted in cambium kill and subsequent attack by ambrosia and wood boring beetles. Decay is now nearly 100% in pre-fire sapwood.

This 18" dbh red fir suffered >50% cambium kill during the 1999 Bucks Fire. It failed in the fall of 2004 with a full green crown.

This 8" dbh, fire-injured white fir was surviving with <5% of its functional xylem and phloem. The crown was still green when it failed in 2004.

Appendix B: Bark Char Definitions

Unburned or light charring **–** light charring has some blackened areas on the bark but unburned portions remain. These unburned portions are generally found in the bark fissures.

Moderate charring **–** with moderate charring, all bark is blackened but the bark characteristics remain.

Deep charring **–** with deep charring, all the bark is blackened and bark characteristics are no longer discernable. Areas of deep char will often have thinner bark than light or moderately charred areas of the bole.

Appendix C: Evidence of significant bark and/or wood boring beetle activity

(Any tree meeting these criteria is predicted to die and no further assessment is required)

Trees should be marked for removal if any combination of the following factors are present over at least 1/ 3 of the bole circumference: 1) pitch tubes with pink or reddish boring dust associated with them; 2) pouch fungus conks and/ or current woodpecker activity (holes into the sapwood and/ or bark flaking, specifically excludes injury caused by sapsucker feeding); 3) boring dust or frass (in bark crevices, webbing along the bole, or that accumulates at the base of the trees). This specifically excludes basal attacks by the red turpentine beetle (large pitch tubes associated with coarse boring dust generally restricted to the lower 2 to 3 feet of the bole or woodpecker activity restricted to this area)* and when the above indicators are only associated with wounds, old fire scars, etc.